Management of Brain AVMs at Bicêtre: a Comparison of Two Patient Cohorts Treated in 1985-1995 and 1996-2005

A. OZANNE, H. ALVAREZ, G. RODESCH, P. LASJAUNIAS

Service de Neuroradiologie Diagnostique et Thérapeutique, Centre Hospitalo-Universitaire de Bicêtre; Le Kremlin-Bicêtre, France

Key words: arteriovenous malformation, cerebral hemorrhage, endovascular therapy, angiography, embolization, outcome

Introduction

Management of brain AVMs at Bicêtre Hospital has not changed significantly during the last 20 years since our initial description of their angioarchitecture and risk factors published in 1986. Our treatment strategy remains unchanged and prioritizes clinical over morphological results. The degree of risk during the procedures as well as the morbidity after treatment has been carefully analyzed and similar treatment strategies are employed for vein of Galen malformations, pediatric brain AVMs and spinal cord AVMs. The price paid for complete embolization is far from ideal and thus we introduced and developped partial targeted embolization. This type of treatment is based on detailed angioarchitecture anatomic knowledge and high-quality angiographic images. These aspects, coupled to the clinical information provide invaluable information in the decision-making process. As such, many patients are better without intervention when its risk is high compared to their symptoms.

In our Series of 1618 Braina AVMs, we present a comparison of two cohorts of patients treated during different time periods and analyze our clinical results. The morbidity and mortality for patients treated during 1985-1995 and from 1996-2005 is presented. For purposes of this presentation, we have excluded patients whose treatment overlapped both time periods. We excluded the children in the second cohort. The results in the first cohort have been already published in 2002 by Meisel et al.

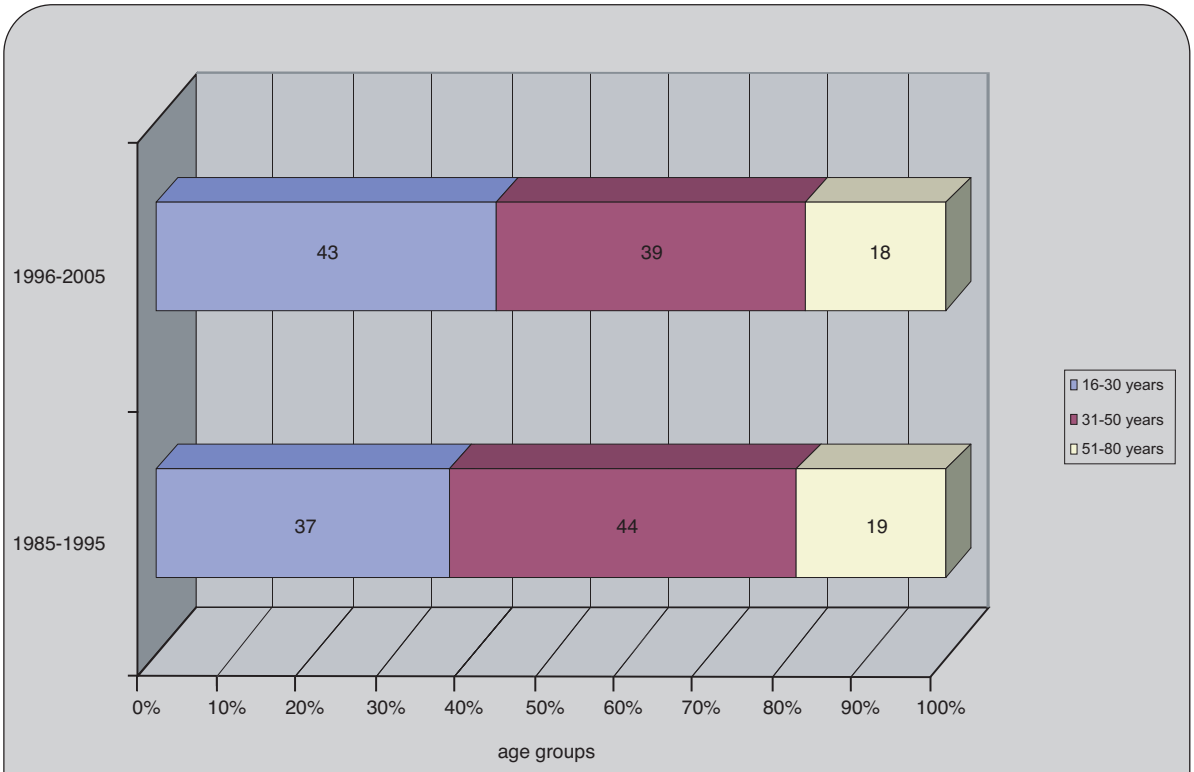
Clinical data

Seven hundred ninety eight brain AVMs were managed from 1985-1995 and 820 from 1996-2005. One hundred fifty seven and 179 children with pial AVM and, 151 and 231 vein of galen malformations are included in each period respectively. The distribution by age groups is shown in table 1 and was not significantly different among the cohorts. Table 2 describes the clinical presentations which again, were not significantly different among both. The number of asymptomatic AVMs was small in both cohorts. Among both cohorts, 5.3% of patients had multiple AVMs including cerebrofacial arteriovenous metameric syndromes (CAMS).

In the first cohort, a total of 499.8 patient-years were generated, while 503.9 patient-years were generated from the second cohort. During 1996-2005, 283 adults were treated one or more times.

The referral pattern at our institution makes morphological and even clinical follow-up difficult in many instances. Overall, follow-up in

Table 1 **Age Groups in Adults**



age (years)	0-15(*)	16-30	31-50	51-90	total of adults	mean of age in adults (y)
1985-1995	157**(151*)	185	215	90	490	36,6
1996-2005	179**(231*)	178	159	73	410	36,11

** Vein of Galen. In the mean time vein of Galen malformations were also taken in charge. During the first period, 798 intracranial intradural AVMs were included, versus 820 during the second period (half of which being pediatric cases).*
*** Pial AVMs.*

children (309 from 1985-1995 and 410 from 1996-2005) was easier due to relationship established between their families and our team.

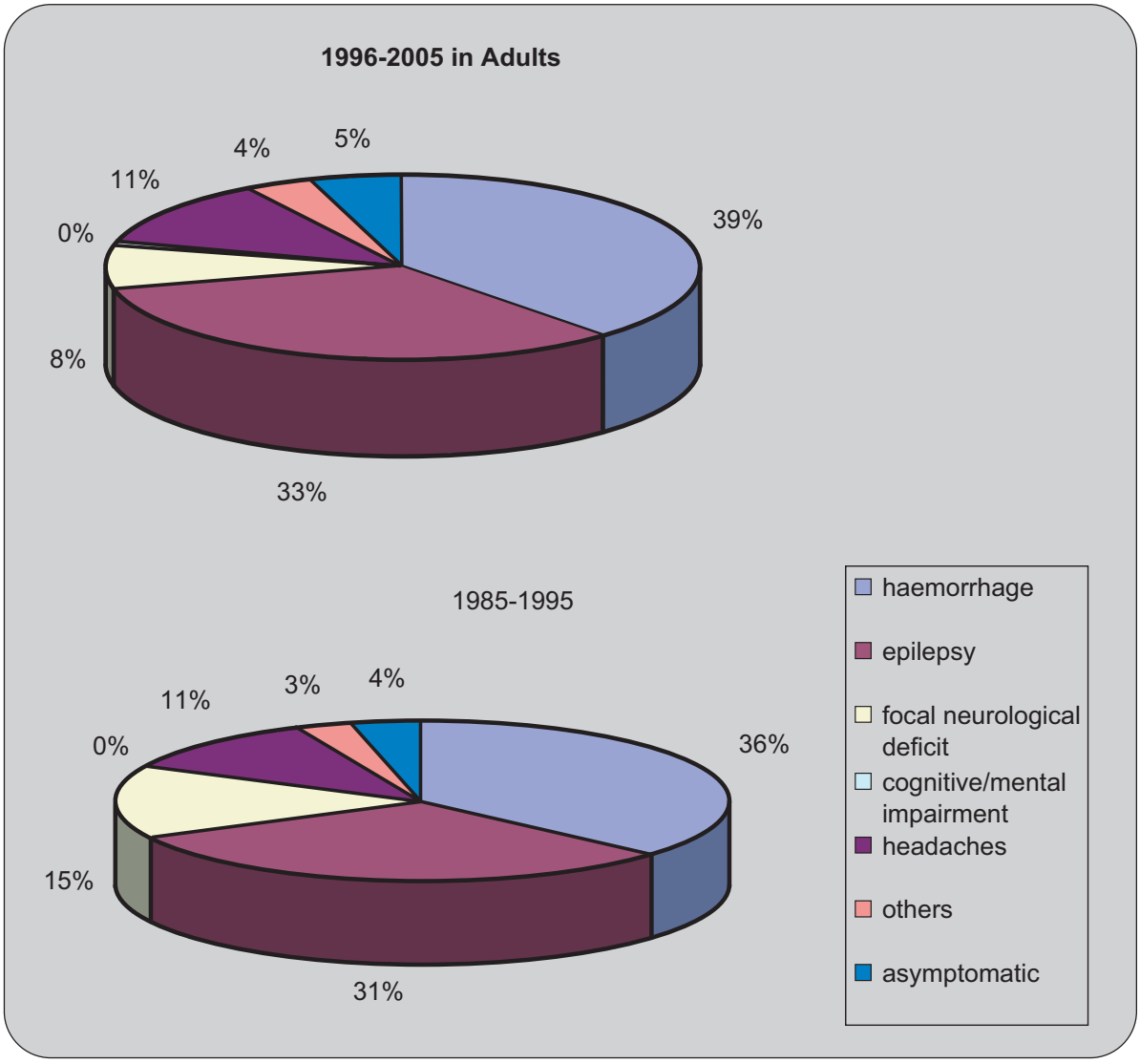
Morphological Results

The rate of complete exclusion of the AVMs was similar for both cohorts. In the first cohort, the rate of exclusion achieved in children was higher than for other age groups (41% in single-hole pial fistulas and over 50% in vein of Galen malformations). The overall rate of finished treatment in the first group was 45% while in the second group it was 32%. Patients in the second cohorts are only adults and many of them are still under active treatment.

Perioperative Morbidity and Mortality

Regarding these issues, no significant differences were found in both cohorts. Some trends need to be high-lighted: symptomatic hemorrhages occurred similarly in both groups (2.47% vs. 2.8%), and one-half of treatment-re-

Table 2 **Clinical Presentation**



lated hemorrhages were not symptomatic and seemed to be related to ruptured feeding vessels or nidus per procedure. Persistent symptoms were fewer in the second cohort (2.47% vs. 3.7%, p=0.33).

In two patients, follow-up Karnovsky grades of 70 or less were found but one of them had a Karnovsky of 40 at admission. Hemorrhage resulted in two deaths but peri-operative mortality was about 1%.

One patient died after thrombolysis needed for an arterial embolus.

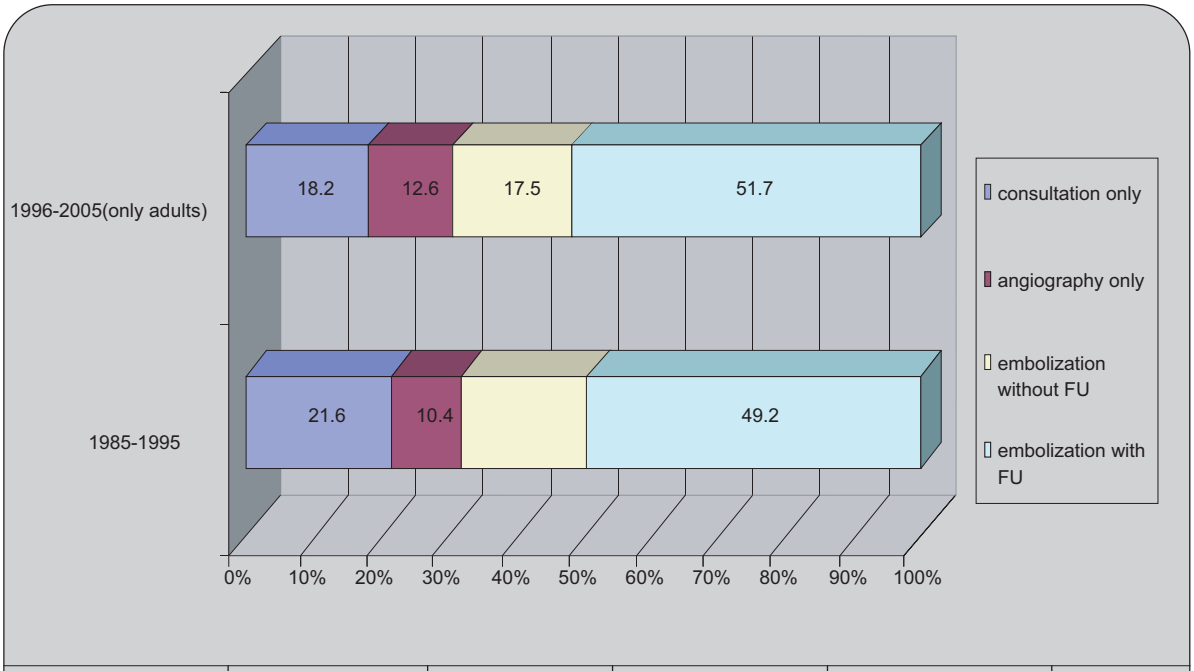
Transient deficits not associated with hemorrhages were fewer in the second cohort (3.54% vs. 5.3%, p=0.25).

Permanent deficits, regardless of the presence of hemorrhages with Karnovsky grades below 70 occurred in 1.41% of patients in the second cohort.

Hemorrhages after Embolization

Five patients in the Second cohort had recurrent bleeds resulting in two deaths. One patient that died, presented with malignant arterial hyperten-

Table 3 **Managment of AVM**



	consultation only	angiography only	embolization without morphologic FU	embolization including morphologic FU	total
1985-1995	143	69	124	326	662
1996-2005 (only adults)	75	52	72	212	411

** FU: Follow-up*

Table 4 **Patients treated by Embolization and Follow-up (patients-years)**

	patients	patient-years
1985-1995	450	499.8
1996-2005	283	503.9
1996-2005-Embolization (not followed by any radiosurgery nor surgery)	253	353.3

– 503.9 patient-years for 283 treated patients *during 1996-2005 (27 embolisations were followed by radiosurgery, 3 by surgery).*
– 353.3 patient-years for 253 treated patients by embolization (not followed by any radiosurgery nor surgery) during 1996-2005.
– 499.8 patient-years for 450 treated patients *during 1985-1995.*

sion. The other patient that died, had received radiation therapy two years previously. One patient had a Karnosvky of 70 (same as admission). Only one of the patients with recurrent bleeds was felt to be curable and still under treatment; his last Karnovsky was 80. In most patients with recurrent bleeds, we believe that their AVMs were incurable based on their size and location. With a larger

Table 5 **Perioperative Morbi-mortality**

	1985-1995 (nb/%) n=450	1996-2005 (nb/%) n=283
Early Hemorrhage	na	15/5.3
Symptomatic Hemorrhage	13/2.8	7/2.47
Severe (karnovsky<=70) Symptomatic Hemorrhage	na	2/0.71
Non Hemorrhagic Transitory Symptom	24/5.3	10/3.54
Non Hemorrhagic Persistent Symptom	17/3.7	6/2.12
Global (Hemorrhagic or not) Persistent Symptom	na	16/5.65
Severe (Karnovsky<=70) Global Persistent Symptom	na	4/1.41
Cases of Death	5/1.1	3/1.06 (including 2 hemorrhages)

Table 6 **Perioperative Symptomatic Intracranial Hemorrhage**

patients	age	Kpre	n° E	ETE-H(d)	FU (m)	hemorrhage consequences	Kfu	Morphologic Results(%)
p.1	61	50	2	0,5	6		0	100
p.2	32	40	3	3	5		0	70
p.3	55	90	2	4	7	hemiplegia, “héminégligence”	60	70
p.4	44	40	6	0	60	motor deficit	60	50
p.5	50	80	7	15	84		80	90
p.6	33	90	5	1	21	coma/deficit	80	40
p.7	59	90	1	15	3		90	65
p.8	41	100	4	20	26		90	70
p.9	28	90	6	1	24	seizure	90	85

Kpre: Karnovsky at presentation. Kfu:Karnovsky follow-up. ETE-H(d):Elapsed-Time between Embolization and Hemorrhage (days). FU(m): Follow-up (months).

Table 7 **Perioperative Morbidity: Non Hemorragic Persistent Symptoms**

	Age	Symptoms	Kpre	Kfu	Deep AVM	Size of AVM(cm)
p.a	56	Worsening Cerebellous syndrome	70	60	yes	3 to 6
p.b	36	Dysphasia	90	70	no	<3
p.c	17	Worsening Epilepsy	80	80	no	>6
p.d	36	Sensory-motor Deficit	90	90	no	3 to 6
p.e	56	Dysphasia	100	90	no	3 to 6
p.f	30	Worsening Sensory Deficit	90	90	yes	3 to 6

Table 8 **Intracranial Hemorrhage (ICH) after Embolization**

	1985-1995	**1996-2005***	**1996-2005-Embolization (not followed by any radiosurgery or surgery)**
Remote Hemorrhage	12	5	4
Total Embolized cases	450	283	253
Patient-years	499.8	503.9	353.3
Annual Risk of Hemorrhage	2.4	0.99	1.13

** only adults*

amount of patient-years, the risk of recurrent hemorrhages decreased. The annual risk for recurrent hemorrhages was 2.6% in the first cohort and 1.13% in the second. When patients were treated by a combination of embolization, irradiation and surgery when indicated, the annual re-bleed risk was 0.99%.

References

1 Lasjaunias P, Manelfe C et Al: Angiographic architecture of intracranial vascular malformations and fistulas-pretherapeutic aspects. Neurosurg Rev 9: 253-263, 1986
2 Lasjaunias P, Manelfe C et Al: Endovascular treatment of cerebral arteriovenous malformations. Neurosurg Rev 9: 265-275, 1986.
3 Hofmeister C, Stapf C et Al: Demographic, morphological, and clinical characteristics of 1289 patients with brain arteriovenous malformation. Stroke. 31: 1307-1310, 2000
4 Mansmann U, Meisel J et Al: Factors associated with intracranial hemorrhage in cases of cerebral arteriovenous malformation. Neurosurgery 46: 272-281, 2000.
5 Meisel HJ: Cerebral arteriovenous malformations and associated aneurysms : Analysis of 305 cases. From a serie of 662 patients. Neurosurgery 46: 793-800, 2000.
6 Suh DC, Alvarez H et Al. Intracranial haemorrhage within the first two years of life. Acta Neurochir (Wien) 143: 997-1004, 2001
7 Mansmann U, Lasjaunias P et Al: Treatment of patients with cerebral arteriovenous malformations [4]. Radiology 223: 879-880, 2002.
8 Meisel HJ, Mansmann U et Al: Effect of partial targeted n-butyl-cyano-acrylate embolization in brain avm. Acta Neurochirurgica 144: 879-888, 2002.
9 Berenstein A, Lasjaunias P et Al: Cerebral vascular malformations. Surgical neuroangiography. Springer 2004, 609-734.
10 Yoshida Y, Weon YC et Al: Posterior cranial fossa single-hole arteriovenous fistulae in children: 14 consecutive cases. Neuroradiology 46: 474-481, 2004.
11 Lasjaunias P: Managment of vein of galen aneurysmal malformations. Neurosurgery 2005, in press.
12 Weon YC: Supratentorial cerebral arteriovenous fistulas (avfs) in children: A review of 41 cases with 63 non choroïdal single-hole avfs. Acta Neurochirurgica 147: 17-31, 2005.

Prof. Pierre Louis Lasjaunias, PhD
CHU de Bicêtre
Service de Neuroradiologie
78, rue du Général Leclerc
F 94275 Le Kremlin Bicêtre Cédex
France
E-mail: pierre.lasjaunias@bct.ap-hop-paris.fr